FEDERAL REPUBLIC OF GERMANY
GERMAN PATENT OFFICE

German classification: 12d. 1/03

Published Patent Application 1,642,849

File No.:	P 16 42 849.2 (M 73108)
Application date:	March 9, 1967
Date late opened public inspection:	April 29, 1971

Title:	Arrangement for the Treatment of Liquids with Adsorption Agents or Ion Exchangers
Applicant:	Metallgesellschaft AG, 6000 Frankfurt
Named as inventor:	Hitzel, Hans, 6000 Frankfurt

Notice pursuant to Article 7 § 1 Subpar. 2 No. 1 of the Law dated September 4, 1967 (BGBl [German Federal Gazette] I p. 960): December 1, 1969

METALLGESELLSCHAFT
Aktiengesellschaft
No. 4625

Frankfurt/Main, March 8, 1967
-DrEu ESz-

1642849

Arrangement for the Treatment of Liquids with Adsorption Agents or Ion Exchangers.

The invention concerns an arrangement for the treatment of liquids with adsorption agents or ion exchangers, whereby the adsorption or loading and the desorption or regeneration occur in countercurrent and the adsorption agents or ion exchangers are arranged in a container.

Adsorption agents and ion exchangers can adsorb adsorbable substances or exchangeable ions from the liquid to be treated up to a saturation state and can be restored afterwards, by a regeneration treatment with suitable solvents or solutions, to the starting state, which enables re-loading. The adsorbed substances or the salts of the ions exchanged can be recovered from the regeneration liquid.

In countercurrent treatment, the regeneration liquid used for regeneration or desorption is guided in a direction opposite the direction of flow of the solution to be treated through a layer of the particulate adsorption agent or the ion exchanger.

In general, the liquid to be treated is guided from the top to bottom through the adsorption agent or the ion exchanger material. The regeneration liquid is then guided from the bottom to the top through the particulate layer.

The loading or adsorption of the ion exchanger or adsorption agent and the regeneration or desorption in countercurrent has multiple advantages compared to the co-current process, in

which the treatment and regeneration liquid are guided in the same direction through the particulate layer. Thus, in the treatment of liquids with adsorption agents or ion exchangers according to the countercurrent principle in a single process step, a significantly lower residual concentration of the contaminants to be removed and simultaneously a high use of the capacity of the adsorption agent or ion exchanger are achieved. Moreover, with the countercurrent process, the desorption or regeneration of the adsorption agent or ion exchanger is possible with a significantly lower, virtually theoretical chemical consumption. Compared to the co-current process, there is thus the advantage of a smaller number of steps and thus a smaller system size as well as lower consumption of elution or regeneration agents.

The advantages of the countercurrent process can, however, only be fully utilized when no rearrangements occur during the flow-through of the layer consisting of ion exchangers or adsorption agents by the loading liquid or the regeneration liquid. This requirement is not easy to meet since adsorption agents or ion exchangers are for the most part products which already begin to float with slight upward flow in liquids, such that this can generate turbulence and rearrangement. This circumstance makes the technical realization of the countercurrent process very difficult. The previously disclosed arrangements provide, for example, for pressing the material against an upper discharging arrangement in the treatment of the adsorption agent or ion exchanger in the upward flow of the material and thus to fix the bed. In the subsequent treatment from the top to bottom, the bed is lowered again. Turbulent motion through the bed is above all prevented by the fact that appropriate built-in components, for example, perforated plates, are provided. These measures can be implemented only with relatively small container diameters, but this also causes certain disadvantages, such as, the possibility of gas separation below the bed impacted in the countercurrent, as well as the necessity that the adsorption agent or the ion exchanger must be fixed in a space with only a very low dead volume, which is generally measured according to the swelling properties of the material. There thus exists no possibility of freeing the material in this space, if necessary, by backwashing of contaminants and abrasion products, such that separate containers must be provided for the backwashing. Apart from the fact that rearrangement of the bed with the generation of the countercurrent and with the

subsequent change in the direction of flow can hardly be avoided, in particular with relatively large column diameters, i.e., greater than 2 m or more and also with built-in components, a significant equipment outlay arises with the separate backwash devices with relatively large containers.

The arrangement of a layer of an adsorption agent or of an ion exchanger between two liquid-permeable plates is also usable only if the layer does not change its volume as a function of the loading state.

With most adsorption agents and ion exchangers, a change in the volume per mass unit also occurs, however, with every change in the loading state. In some ion exchangers, this change in volume can amount to as much as 20 %.

German patent 832,596 describes a container for particulate filter masses, adsorption agents, and ion exchangers in a fixed layer, in which the particle bed rests on a liquid-permeable plate and is held together on the surface by a height-adjustable sieve-plate sliding in guides on the housing jacket. This sieve-plate also has the shortcoming of high flow resistance. Besides that, these sieve-plates must be inserted directly into the housing jacket to prevent leakage of filter material at the periphery. Consequently, these plates readily hang up due to tilting and do not fulfill their intended purpose. Moreover, with this arrangement as well, backwashing of the material is not possible.

Ion exchangers usually are generally spherical in shape and are free-flowing in mixture with liquids. The same is also true for particulate adsorption agents with particle sizes of 0.5 to 2 mm. This property of ion exchangers or adsorption agents makes it possible to move them in the form of a compact bed with the help of liquids.

In the arrangement according to the invention, this property of ion exchangers and adsorption agents is used to be able to load and regenerate them after the countercurrent process.

The invention is further explained with reference to the exemplary schematic figures.

Fig. 1 depicts an arrangement according to the invention in vertical section.

Fig. 2 through 4 depict the position of the bed in the arrangement according to Fig. 1 in various operating states.

Fig. 5 depicts another arrangement according to the invention in vertical section.

The same parts in the figures are referenced with the same numbers.

The arrangement according to the invention depicted in Fig. 1 consists of the cylinder 1, which is closed on the top and bottom by the expediently arched covers 2 and 3. The horizontal plate 4 is arranged in the top part of the container formed by the cylinder 1 and the covers 2 and 3. A concentrically arranged cylinder 5, sealed on the top by the plate 4 and ending open on the bottom a short distance above the cover 2, is located inside the container. This divides the space of the plate 4 into an outer annular space 6 and an inner cylindrical space 7. The part of the plate 4 closing the annular space 6 at the top is designed liquid-permeable, i.e., as a nozzle-plate or a sieve-plate. The line 8 running into the container ends in the space 7 a short distance below the plate 4 in a liquid distribution and collection arrangement 9. The line 10 ends in a liquid distribution arrangement 11 which is arranged in the space 7 near the lower end of the cylinder 5. Between the top cover 3 and the plate 4 is located the space 12 from which the line 13 runs outward. The spaces 6 and 7 are now, as indicated by hatching in the figure, filled with exchanger or adsorption material until with maximum swelling of the exchanger or adsorption material, a small dead volume of a few percent of the total volume of the spaces 6 and 7 remains. (The volume expansion through swelling can amount with ion exchangers and adsorption agents to as much as 30 %.)

The arrangement can be used as following for the treatment of liquids:

The liquid to be treated is fed in via line 8 and enters at the upper end of the inner cylinder 5 through the distribution arrangement 9 into the inner cylindrical space 7. It flows downward at relatively high speed in the cylinder 5 and moves the ion exchanger or adsorption material in front of it as a result of the flow resistance like a piston, which is forced into the outer annular space 6 until the dead volume in the annular space 6 is filled, and the material is dammed up against the liquid-permeable part of the plate 4. (This state is depicted in Fig. 2.) The bed is thus fixed in its position. Only a small fraction of the entire quantity of the ion exchanger or adsorption agent remains in the inner cylinder 5. The liquid diverted on the lower end of the cylinder 5 flows upward in the space 6 and flows through the liquid-permeable part of the plate 4 into the space 12 and from there flows away via line 13. Thus, the liquid to be treated flows through the majority of the adsorption or exchanger material from the bottom to the top by without having to worry about rearrangement. Before the reversal of the direction of flow with the following desorption or regeneration, the small portion of the material still found in the inner cylinder 5, which is contaminated primarily by possible impurities of the liquid to be treated, can be backwashed separately. For this, the backwashing liquid is fed in via the line 10 and the distribution device 11 and discharged via the liquid collection arrangement 9 and the line 8. The position of the particulate layer during the washing procedure is depicted schematically in Fig. 3.

At the time of desorption or regeneration of the material, the regeneration liquid is fed in via the line 13 and flows from the top to bottom through the material in the annular space 6. The material is moved from the top downward and partly pressed back into the inner cylinder 5. In most of the mass of the material in the outer annular space 6, no mixing or whirling occurs. The liquid flowing downward in the space 6 is diverted at the lower end of the cylinder 5 into the space 7 and flows upward inside the cylinder 5. The regeneration liquid is removed from the

space 7 via the liquid collection arrangement 9 and the line 8. The position of the bed material during regeneration is depicted schematically in Fig. 4.

The liquid to be treated may also be introduced through the line 13 and removed through the line 8 (bed state as in Fig. 4). The regeneration then takes place in the reversed flow direction of the liquid. The regeneration liquid is then conducted through line 8 and discharged through line 12. For this case, Fig. 2 depicts the bed position.

The dimensions of the arrangement must be selected such that with the introduction of the liquid through the line 8, the bed is shifted into the position shown in Fig. 2. For this to happen, the horizontal cross sections of the space 7 and the annular space 6 must have a specific relationship to each other. The ratio of the cross sections between the cylindrical space 7 and the annular space 6 is expediently selected from 1 : 10 to 1 : 2.

The lower end of the inner cylinder is expediently expanded outward conically. Such a conic expansion is indicated schematically in the figures and referenced as 14.

Between the lower end of the inner cylinder 5, that is, in the arrangement depicted in the figures, between the conic expansion 14 and the bottom 2, there is an annular passage between the space 7 and 6. The ring surface of this passage is selected large enough that it is roughly as large as the cross-sectional surface of the space 7. However, the ring surface of the passage 15 may also be dimensioned up to the size of the cross-section of the annular space 6.

Fig. 5 depicts another arrangement according to the invention which makes it possible to accommodate more ion exchanger or adsorption material in the container volume.

In contrast to the arrangement depicted in Fig. 1 through 4, the inner cylinder 5 in the arrangement depicted in Fig. 5 extends all the way to the upper cover 3, which then seals the space 7 in the upward direction. The liquid-permeable plate 16 delimits the annular space 6 in the

upward direction. The annular space 17, into which the line 13 opens, is formed between the upper cover 3, inner cylinder 5 and sieve plate or nozzle plate 14. The annular space 17 corresponds to the space 12 in the arrangement depicted in Fig. 1 through 4.

12d 1-03 AT: 9.3.67 OT: 29.4.71

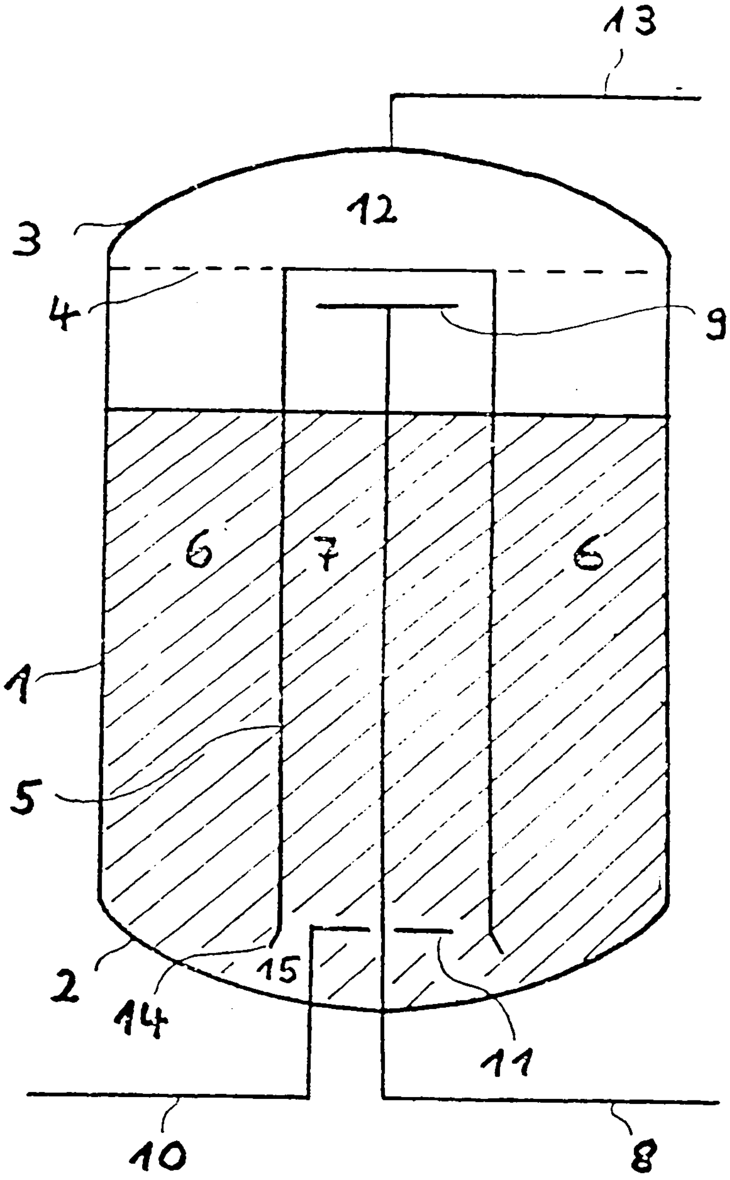

Fig. 1

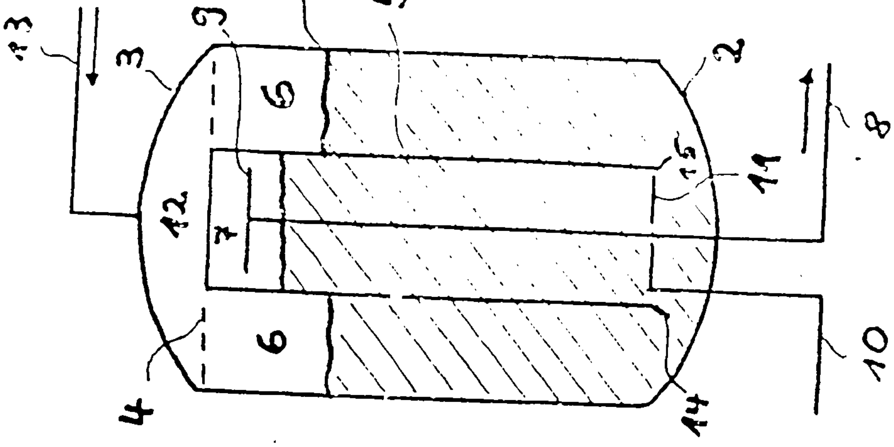

Fig. 4

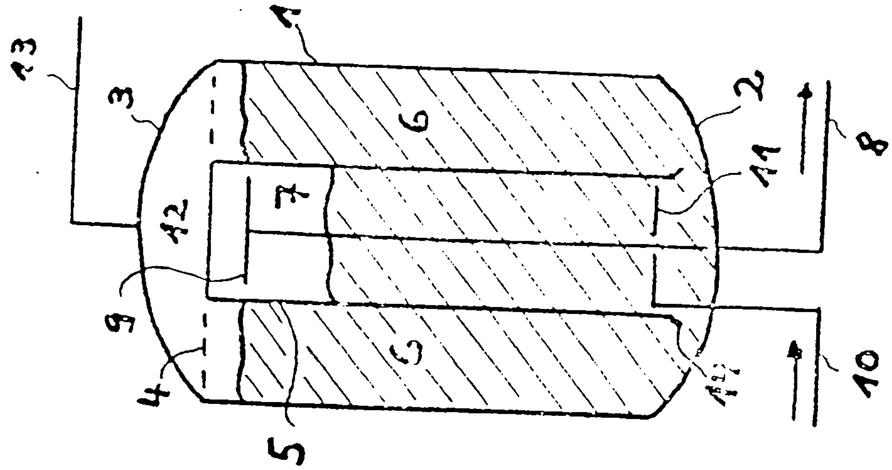

Fig. 3

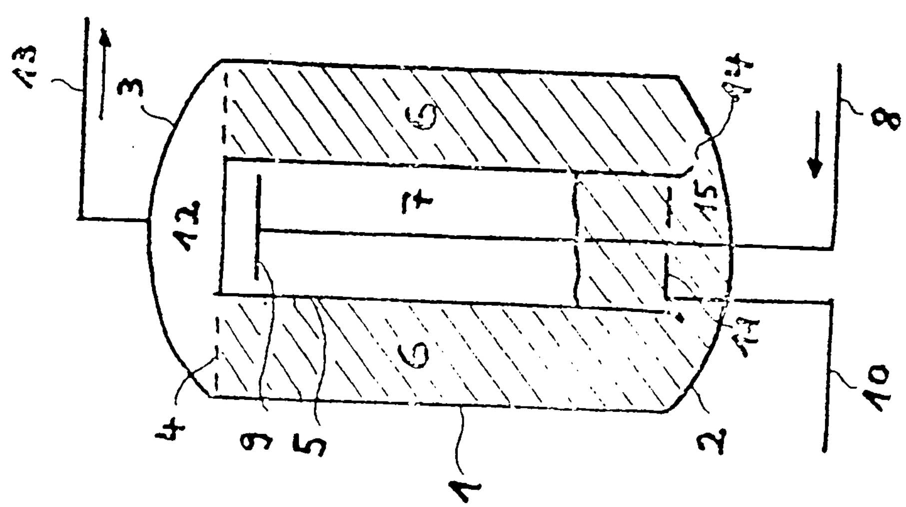

Fig. 2

Ergänzungsblatt zur Offenlegungsschrift 1642849
Deutsche Kl.: 12 d, 1/03
Offenlegungstag: 29. April 1971

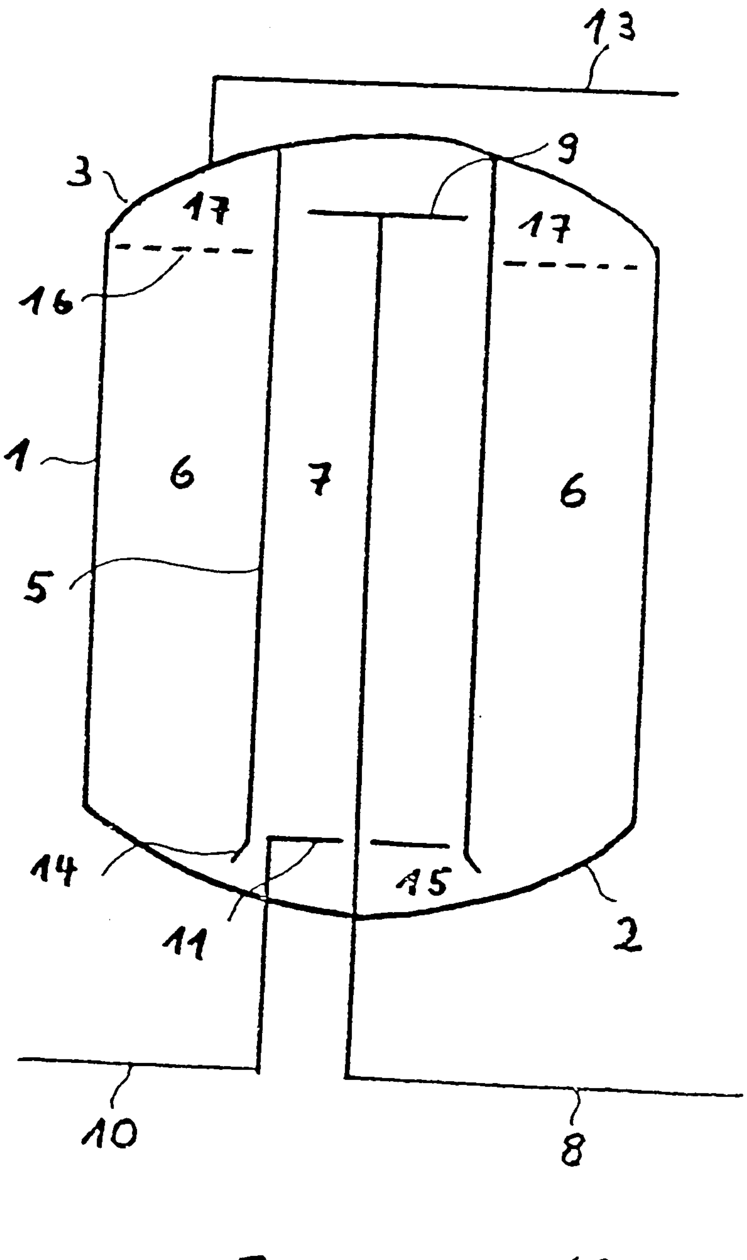

Fig. 5

109818/1627